MANUAL OF PACKAGE OF PRACTICES FOR PRODUCTION OF EXPORTABLE TABLE GRAPES

NATIONAL RESEARCH CENTRE FOR GRAPES

P.B. No. 3, Manjri Farm P.O., Solapur Road
PUNE - 412 307, Maharashtra, India

Tel.: 020-26956000, 26956006 Fax: 020-26956099

e-mail: dirnrcg@icar.org.in

website: http://nrcgrapes.nic.in

Compiled by:
Dr. P.G. Adsule
Dr. G.S. Karibasappa
Dr. Indu. S. Sawant
Dr. S.D. Sawant
Dr. R.G. Somkuwar
Dr. A.K. Upadhyay
Dr. K. Banerjee
Dr. S.D. Ramteke
Dr. J. Sharma
Dr. J. Satisha
Dr. A.K. Sharma
Dr. D.S. Yadav
Mrs. S. Salini

Edited by:
Dr. P.G. Adsule
Dr. Indu. S. Sawant
Dr. J. Satisha

Published by:
Dr. P.G. Adsule
Director
National Research Centre for Grapes, Pune

CONTENTS

1. Introduction

India produces about 1.88 million tonnes of table grapes from an area of 84000 hectares. In last two years, the export of table grapes to EU countries has reached in the range of 39,000 to 46,000 tonnes apart from 60,000 to 70,000 tonnes export to Bangladesh and Middle East countries. Export of table grapes is mainly concentrated in states of Maharashtra, Karnataka and Andhra Pradesh. Coloured seedless grapes are exported from January to February while the white seedless grapes are exported from the middle of February to the end of April. Export to UK and other European countries are presently confined to a period of about one month commencing from the middle of March to meet their requirements from mid-April to mid-May. Apart from present exportable white table grape varieties like Thompson Seedless and its clones and coloured varieties like Sharad Seedless (Kishmish Cherneyi) and Flame Seedless, there is a potential for other white varieties like 'Manjri Naveen', a clonal selection of Centennial Seedless of this Institute and coloured varieties like Red Globe, Italia, Fantasy Seedless, Crimson Seedless and Autumn Royal. Standardized cultural practices for these varieties has been placed on website http://nrcgrapes.nic.in. Most popular rootstock used for table grapes to look after the problem of soil and water salinity was Dog ridge and now there is shift to other rootstock like 110R as recommended by this Institute.

2. Quality standards of exportable table grapes

Quality parameters of bunch, in terms of bunch weight and berry appearance (shape, colour and free from foreign smell, taste, visible traces of moulds, skin blemishes) and fruit composition parameters of TSS, acidity and sugar:acidity ratio has to complied as specified under the AGMARK standards notified by Department of Agriculture and Cooperation of Union Ministry of Agriculture. Further food safety standards like Agro-chemical residues in table grapes particularly the Maximum Residue Limits (MRLs) are also to be complied to European Union standards and other importing countries as the case may be. To achieve all the quality parameters one has to also comply to Good Agricultural Practices as specified under the standards. Keeping all these parameters in view, the cultural practices have been suggested viz. the site of vineyard and its resources like nutrients, water and agrochemicals for various purposes. A list of chemicals with CIB label claim for use in grapes and the list of chemicals to be monitored are given in Annexure I and II respectively which has to be complied for the exportable table grapes.

Grape being temperate and perennial fruit crop, it has to be adoptive to tropical situation where the crop is grown commercially in the country. Keeping in view its growth and fruiting in tropical situation two prunings are suggested unlike single pruning in temperate countries. The package of practices are, therefore, outlined based on its pruning time i.e. April (Foundation pruning) and October (Fruit or forward pruning) month in a year. All these package of practices are recommended based on the research findings carried out by ICAR Institutes and SAUs in the country.

Detailed quality specifications are outlined below:

A. Bunch weight / size

The following minimum weight requirements per bunch are laid down for hothouse grapes and for large-berry and small-berry grapes grown in open field as per AGMARK standards.

Grade	Large-berry	Small-berry
'Extra Class'	200	150
I	150	100
II	100	75

AGMARK Quality parameters

The table grapes are graded into three classes defined below:

i. Extra Class: Grapes must be of superior quality. The bunches must be typical of variety in shape, development and colouring and have no defects. Berries must be firm, firmly attached to the stalk, evenly spaced along the stalk and have their bloom virtually intact.

ii. Class I: Grapes must be of good quality. The bunches must be typical to the variety in shape, development and colouring. Berries must be firm, firmly attached to the stalk and, as far as possible, have their bloom intact. They may, however, be less evenly spaced along the stalk than in the extra class. Following slight defects may be accepted, provided these do not affect the general appearance of the produce and keeping quality of the package.

- a slight defect in shape,
- a slight defect in colouring

iii. Class II: The bunches may show defects in shape, development and colouring provided these do not impair the essential characteristics of the variety. The berries must be sufficiently firm and sufficiently attached. They may be less evenly spaced along the stalk than Class I grade. Following defects may be accepted, provided these do not affect the general appearance of the produce and keeping quality of the package.

- defects in shape,
- defects in colouring,
- slight sun scorch affecting the skin only,
- slight bruising,
- slight skin defects.

3. Nutrient and water inputs

Application of nutrients and irrigation to soil depends on the site selected for grape cultivation. Site selection in terms of soil and climatic condition is one of the important factors to be considered before establishing vineyard. Soil properties in terms of soil texture and structure, soil pH, depth, availability and quality of irrigation plays a major role in successful viticulture. Similarly, climatic factors prevailing in the area with respect to rainfall pattern, temperature, light intensity, relative humidity also determines the success of grape cultivation. Though grapes can be cultivated on varied soil and climatic conditions, deep and well-drained soils with pH range of 6.5 – 8.0 is ideal. The soil pH above or below this range is known to restrict availability of some nutrient elements and thus inhibit growth and development. Grapevines generally require hot and dry climate during its growth and fruiting period. Either

very hot or very mild and cold climate during fruit ripening creates imbalance in sugar acid blend thus reducing fruit quality.

Grape vines once planted stays at the site for period of 15-20 years. Favourable rooting environment and proper understanding of the phenology of vine is key to efficient water and nutrient management. Nutrient availability to plants is dependent upon soil pH and its composition, amounts of nutrients in the soil and soil environment. Thus, regular soil testing can determine status and changes in its composition and any toxicity, which may impede nutritional balance. Further, grape roots being spread deep in the soils, vines may not respond to the fertilizer application as predicted by soil testing, hence, petiole testing also becomes very important. The petiole samples should be drawn during both foundation and fruit pruning seasons and sent for analysis to a recognized laboratory in order to know the nutrient status for vegetative growth and fruiting respectively.

Water is a critical input for grape production. Quality of water in terms of salinity, presence of specific ion (Sodium, Chloride, Boron, Nitrate etc.), carbonates and bicarbonates will have an impact on the quantum of water required for the vine cultivation as well as on the nutrient requirement based on vine phenology. Test the irrigation water and soil for presence of heavy metals viz Arsenic, Cadmium, Cobalt, Chromium, Copper, Mercury, Mangenese, Nickel, Lead, Tin and Thallium from the food safety point of view.

Before starting the foundation and fruit prunings, the grower should draw samples from the root zone of the soil to a depth of 30 cm from all sides of the point of application of drip water after harvest (during rest period). Simultaneously, they should also test the irrigation water quality.

Apply fertilizer based on soil test report and also considering the nutrients coming from organic manures and irrigation water. The grower while procuring the fertilizer should also check the label details on the fertilizer bag and ensure from the dealer about its meeting the specifications as per Fertilizer Control Order (1985) of Government of India and latest amendments. Similarly, the grower while procuring composts and organic materials must demand from the supplier or satisfy themselves about the product being free from heavy metals as stated above.

Foundation pruning season

Nutrient and water requirement is given below based on the crop growth stage. The sprouting time of 10-12 days is considered for arriving at a given growth stage. The nutrient and water requirement based on crop growth stages are shown in table 1. The method of irrigation for vineyard is surface or drip system. These recommendations are for guidance purpose only and may change based on site conditions of vineyard.

a) 0-40 days after foundation pruning

Apply recommended amendments and FYM at or before pruning. At the time of pruning apply FYM @ 25 ton/ha. Apply 30% nitrogen of the annual N needs during first 40 days after pruning and 20% of the annual P fertilizer dose between 31-40 days after pruning. Apply Zn and boron during 20- 40 days to promote desired shoot growth. However, if the soil test value indicates deficiency, apply micronutrient (Zn, Fe, Mn and Boron) after bud swelling stage. Apply starter dose magnesium if the deficiency was indicated by the soil and petiole test during the previous fruiting season.

Apply proper quantity of irrigation water based on pan evaporation rates to achieve desired canopy. Expected pan evaporation during first 40 days may range from 8-12 mm per day. Accordingly the irrigation water needed will range from 33,600 to 50,400 litres per hectare per day.

b) 40- 60 days after foundation pruning

Petiole testing: Test the petiole from the leaf at 5^{th} node position from the base of a cane and send for analysis to a recognized laboratory. If the test report indicates the nutrient (s) as excess or very high stop the application of that nutrient.

Apply 40 % of the annual P dose during this period. If potassium deficiency symptoms such as inward leaf curling or shiny spot on leaves is noticed during the first month of growth (vegetative growth), start potassium application early. Apply Mg as per the need indicated by the petiole test. Apply zinc and boron during 40- 60 days as per petiole test report preferably by foliar sprays.

Reduce the irrigation to $1/3^{rd}$ compared to first 40 days to facilitate fruit bud differentiation. Expected pan evaporation during this stage may range from 8-10 mm. Accordingly 11,200 to 14,000 litres of irrigation water will be needed. Excess irrigation or soil moisture at this stage will result in poor fruitfulness.

Grow a green manure crop in the rainy season. It will help in suppressing the weeds also. Plough the green manure crop when it is in flowering stage.

c) 60 to 120 days after foundation pruning

Apply 30% of annual potassium dose during 60 to 120 days after foundation pruning.

This stage also coincides with rainy season hence irrigation may not be needed. If there are no rains continue irrigation as per the requirement.

Fruit pruning season

Nutrient and water requirement is given below based on the crop growth stage. The sprouting time of 10-12 days is considered for arriving at a given growth stage. The nutrient and water requirement based on crop growth stages are shown in table 1. These recommendations are for guidance purpose only and may change based on site conditions.

a) 0-40 days after fruit pruning

Apply recommended amendments and FYM at or before pruning. At the time of pruning apply FYM @25 ton/ha. Apply 30% of the annual nitrogen dose during first 40 days after pruning. Start micronutrient (Zn, Fe, Mn and Boron) and magnesium application after bud swelling stage if the soil test value indicates deficiency and deficiency was established during the foundation stage. Apply magnesium as foliar sprays @ 0.3 to 0.5% for quick overcoming of deficiency. In case of both P and Ca deficiency, application of superphosphate mixed with FYM/composts at the time of pruning will take care of both. Apply Zn and boron during 20- 40 days to promote desired shoot growth preferably as foliar sprays. Take special care of potassium deficiency and start early application of potassium. If the symptoms like inward leaf curling and or shiny spots are noticed on the leaves, apply 25 kg of sulphate of potash and spray potassium sulphate @ 3-5 g/litre depending on leaf age.

Expected pan evaporation during first 40 days when vines are pruned in October may range from 6-8mm per day. Accordingly, the irrigation water needed will range from 25,200 to 33,600 litres per hectare per day.

b) 40- 70 days after fruit pruning

Petiole testing: Test the petioles from the leaf opposite to cluster/bunch at full bloom stage. Modify the fertilizer doses accordingly. If the test report indicates the nutrient (s) as excess or very high stop the application of that nutrient.

Apply 30% of annual phosphorus dose during this period. Apply magnesium preferably by foliar spray not exceeding 0.5 % concentration. If the potassium deficiency symptoms like inward leaf curling or shiny spots are noticed on the leaves, apply 25 kg of sulphate of potash and spray potassium sulphate @ 3-5 g/litre depending on leaf age. Apply zinc and boron preferably by foliar sprays to overcome the deficiency fast. Boron may also be applied in soil via drip irrigation apart from foliar spays in case of sever deficiency.

Reduce the irrigation during 41-55 days in clayey soil to one-third compared to earlier stage to facilitate berry thinning. Expected pan evaporation during this stage may range from 4-6 mm. Accordingly 5,600 to 8,400 litres of irrigation water per hectare will be needed. Fifty five days after fruit pruning increase the amount of irrigation water. Expected pan evaporation during this stage may rage from 3-6 mm. Accordingly, 12,600 to 25,200 litres of irrigation water per hectare will be needed. Light textured soil will need more irrigation and the irrigation should be reduced to 50% only compared to vegetative growth stage.

c) 70 to 105 days after fruit pruning

Apply 30% each of nitrogen and potassium dose during this period. Apply magnesium preferably by foliar spray not exceeding 0.5 % concentration. For overcoming calcium deficiency, apply preferably as foliar application. Two to three sprays may be needed.

Expected pan evaporation during this stage may range from 3-6 mm. Accordingly, 12,600 to 25,200 litres of irrigation water per hectare will be needed.

d) 105 days after fruit pruning to Harvest

Apply 30% of potassium dose during this period. Apply magnesium preferably by foliar sprays not exceeding 0.5 % concentration in case of suspected deficiency.

Expected pan evaporation during this stage may range from 8-10 mm. Accordingly, 33,600 to 42,000 litres of irrigation water per hectare will be needed. Do not over irrigate otherwise it may lead to problems like water berry and cracking.

Table 1. Irrigation schedule based upon pan evaporation and fertigation schedule for various growth stages of Thompson Seedless vines raised on Dogridge rootstock (see note below)

Growth Stage	Expected duration (days after pruning)	Water requirement (litres/day/hectare per mm of evaporation)	Month of operation	Expected Pan evaporation (mm)	Approximate water (litres /hectare/ day)	Nutrient application (kg/ha)		
						N	P_2O_5	K_2O
Foundation Pruning								
Shoot growth	1-30	4200	April-May	8-12	33,600-50,400	60	-	-
Shoot growth	31-40	4200	April-May	8-12	33,600-50,400	20	71	-
Fruit bud differentiation	41-60	1400	May-June	8-10	11,200-14,000	-	142	-
Cane maturity and Fruit bud development	61-120	1400	June-August	0-6	0-8,400	-	-	80
121 days - fruit pruning	121 -	1400	August-Fruit pruning	0-6	0-8,400	-	-	-
Fruit Pruning								
Shoot growth	1-40	4200	October-November	6-8	25,200-33,600	80	-	-
Bloom to Shatter	41-55	1400	November - December	4-6	5,600-8,400	-	53	-
Berry growth and development	56-70	4200	December - January	3-6	12,600-25,200	-	53	-
Berry growth and development	71-105	4200	December - January	3-6	12,600-25,200	80	-	80
Ripening to Harvest	106-harvest	4200	January - March	8-10	33,600-42,000	-	-	80
Rest period	Harvest to Foundation pruning	-	March-April	8-10	-*	26	36	26

The schedule has been worked based on experiments in heavy soils and therefore this may be taken as guidelines.

Note:

- One kg P=2.29 kg P_2O_5 and one kg K= 1.21 kg K_2O
- Depending on water quality, the amount of water needed may change. Irrigation should not be applied after the soil has reached field capacity after rain.
- The above nutrient values are the guidelines for distributing the NPK doses values may change based on the site and climatic conditions.

- Under normal climatic conditions generally, it takes 10-12 days for sprouting.
- The nutrient applications should necessarily take into account soil, petiole and water testing report.
- Contribution of nutrients from other sources like composts, FYM, green manuring etc. should also be taken into consideration for adjusting the nutrient dose. All the manures and fertilizers, irrigation water and other inputs should be tested for presence of heavy metals (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sn, and Tl) before use.

Micronutrients

- Amongst the micronutrients, zinc and iron are the most commonly deficient nutrients.
- Due to large variation in the type and content of calcium carbonate in soil, no specific recommendations are available. However, under established deficient conditions, on an average 50 kg per hectare each of zinc sulphate and ferrous sulphate and manganese sulphate should be applied per season.
- Micronutrients are preferably applied as foliar application and based on petiole analysis. On an average, 3-4 sprays of 0.2 – 0.4 % of sulphate forms of Zn, Mn and Fe in a pruning season meet the crop needs.
- Boron is strictly applied on the basis of petiole analysis report.

4. Pruning and canopy management

Canopy refers to the size and shape of vine structure. The size and shape of the canopy is dependent on number and length of canopy components such as primary and secondary arms, canes, shoots and also on how these components are oriented in a given trellis / training system.

Ideal canopy should fulfil the following requirement:

i. It should give the grapevine a desirable shape and support the load of canopy.

ii. It should be less expensive.

iii. It should offer scope for convenient operations in the field.

iv. It should offer scope for easy mechanization.

v. It should give maximum proportion of quality grapes per acre area.

vi. It should have adequate number of fruitful canes.

vii. It should allow sufficient light and ventilation into the canopy during the growth season.

viii. It should have sufficient coverage to nourish and protect the bunches during the fruiting season (November-March).

ix. It should avoid overlapping of the foliage to facilitate efficient photosynthesis by every leaf.

x. It should offer scope for effective coverage of sprays with pesticides and growth regulators.

xi. It should not build up micro-climate that is congenial for disease development.

Canopy management refers to the practices followed to obtain the ideal characteristics in various canopy components to realize the maximum yield of export quality grapes. The requirement of canopy during each pruning in tropical region is as below.

To achieve these conditions in vine canopy following are the strategies and practices to be followed after foundation pruning.

i. Shoot thinning is to be done at 4-5 leaf stage only. This helps in reducing the loss of nutrients from the vine.

ii. The number of shoots retained on vine should be 0.67 per ft.^{2} for export quality however, it can be one per ft^2.

iii. The canopy should be open during April – September so that there will maximum harvest of sunlight.

iv. The shoots on each cordon should be vertically positioned to harvest maximum sunlight required for fruit bud differentiation.

v. While removing the excess shoots from the cordon, remove both vigorous and weaker shoots so that all the shoots will be uniform in diameter.

vi. Sub-cane system in the vineyard should be followed based on the vine vigor. Vines with vigorous shoots should follow sub cane system while straight cane is followed in less vigorous vines.

vii. While making the sub cane, pinch the shoot to 7- leaves at 9- leaf stage of the shoots to develop sub-canes.

viii. Top the side shoot again at 5th leaf when it is at 7- leaf stage.

ix. Impose soil moisture stress at 7+5 leaf stage. This helps in increasing the fruit bud differentiation.

x. Top the shoots to 15- leaves (7+8) when the shoots start maturing.

Following are the practices to be followed for fruit pruning

i. Collect the canes of different category and examine the buds under microscope for fruit bud differentiation in the buds. This helps in deciding the actual position of fruitful buds so that the decision on fruit pruning can be taken up.

ii. The canes of 6 mm and less diameter are to be removed during fruit pruning.

iii. Swab hydrogen cyanamide only to apical 2-3 buds on each cane. This helps in early and uniform bud break.

iv. Based on the bud break and the bunch emergence, shoot thinning is to be followed at 4-5 leaf stage.

v. Retain the bunches based on vine spacing. Retain one bunch per 1.5ft^2 of canopy for export grapes. However, for local market one bunch for every ft^2 area is sufficient.

vi. Considering the target and our objectives, the bunches and shoots are to be removed at the earliest (4-5 leaf stage)

vii. Bunch thinning should be followed at pre- bloom stage only.

viii. Retain only one or two bearing shoots on each cane. If the cane diameter is more than 8 mm, retain two bearing shoots and only one shoot if the diameter is less than 8 mm.

ix. Encourage the shoot growth by applying more nitrogen and water until one month after fruit set.

x. Thin the berries and clip the clusters to reduce the number of berries in relation to the cane thickness. Retain 16 berries in a cluster per every mm diameter of the cane.

xi. Position the shoots to provide shade to the bunches on the South-West side of the canopy.

xii. Retain only 100-120 berries in a bunch and remove all excess number of berries. This operation should be done immediately after berry setting. This helps in proper berry development and achieving the desirable berry size required for export.

xiii. Shoot topping is done at 10-12 leaf above bunch after forward pruning to avoid competition for nutrients by the shoot and consolidate the food material in the developing bunches. This helps in increasing the berry size.

xiv. To increase the berry size, girdling is one of the important operations beside use of growth regulators and cluster thinning. All these are complementary to each other. Therefore care should be taken that there is always judicious use of these practices in the cultivation practices. Girdling helps in increasing the berry size at least by one mm diameter.

xv. The time of girdling differs from varieties. In Thompson Seedless, the girdling is done at 4-6 mm berry size whereas in Sharad Seedless grapes it is done at 6-8 mm berry size.

5. Bioecology and Management of insects pests and mites

5.1 Bioecology

Thrips and Jassids

These are the sucking pests, which prefer to feed on the succulent and juicy tender parts of the vine like young growing shoots and appears after the foundation and fruit pruning of the crop. These insects enjoy the warm, bright sunlight combined with slightly higher temperature and low relative humidity. They disperse very easily in the vineyard as they are very active insects and also can be easily carried from one plant to another by wind. Both nymphs and adults suck the plant juice, which result in the curling and cupping of young leaves. The damage after the foundation pruning is mainly confined to vegetative parts of the vine but after the fruit pruning, in addition to the damage on vegetative parts, they also damage the flowers and young berries. Thrips suck the sap from the ovaries of flowers in the berry setting stage, which leads to flower shedding and loss in yield. This is the loss in terms of quantity; however the loss in terms of quality is also very serious as sap sucking by these insects results in the brownish net-like appearance on the surface of the berries as well as scab formation in the berry pulp. So the new flush emergence stage, flowering and berry setting stages are the critical stages of the plant for damage by thrips. Jassids mainly appears during the flushing stage of the plant soon after pruning.

Mealybugs

Mealybugs are the major groups of sucking pests affecting the crop especially serious during the sugar development in berries. These insects prefer high temperature and comparatively less relative humidity. Population of mealybugs is usually low from June to November and starts increasing from mid December onwards. During January, they migrate from the trunk, cordons and shoots to developing berries. Both the adults and nymphs suck the plant sap from the tender plant parts during the new flush emergence stage especially after fruit pruning, which leads to the curling and malformation of plant parts and thereby arresting further growth of the shoot. During bunch development stage, they migrate to bunches and produce profuse quantity of honeydew which leads to sooty and sticky bunches, which considerably reduces the quality and marketability of the fruits. Ants association with these pests will further aggravate the problem as they help the pest to migrate easily from one plant to another besides protecting from the natural enemies of the pest.

Flea beetles

These are metallic brown beetles with six black spots on the dorsal side. They are active especially during the bud breaking stage of the plant after the pruning. Adults are damaging stage of the pest. Adults eat away the young buds and leaves. As a result the shoot growth is arrested. Linear and rectangular shaped holes on the leaves reveal the damage by this pest. Grubs are seen in the soil by feeding the roots of the plant but usually not making much serious damage to the plant.

Caterpillars

Caterpillars are biting and chewing type of insects and usually are not very serious pests of grapes, even though occasionally they emerge as a serious pest. During the flowering and fruiting stage of the crop, *Helicoverpa armigera* may become serious pest. They can be easily monitored by regular visit of vineyards and checking for the presence of pests.

Mites

Mites are important group of non-insect pest attacking grape. They are also sucking pests and prefer the high temperature and low relative humidity. Their population starts increasing from second week of December and reaches to a peak during February-March. They prefers to feed on older leaves but increase in population leads to their migration to even bunches. Both nymphs and adults suck the plant sap and weaken the vine. Serious infestation leads to extensive defoliation especially during January to March-April and reduces the TSS in the berries and resulting into poor quality fruits.

Stem Borer

Stem borers are emerging as a major pests in vineyards now a days. These are the group of pests which can kill the whole plant compared to other pests in grapes. Adult emergence coincides with the onset of monsoon during May-June. More than one species of stem borer were found in infesting grapevines. Some are black coloured beetles with so much of variation in body size. Others are gray coloured and stout bodied large beetles. Soon after mating, the females lay the eggs in the crevices of bark. After hatching, the grubs bore into the plant and the remaining part of their life cycle will be inside the plant itself. In the later stage of infestation, bore holes and leaves with interveinal chlorosis can be seen in the plant. Usually these are the exit

holes of the pest. It is found that more than one borer are affecting one plant and parts like trunk, cordons and also branches having more than 1.5-2 cm diameter affected by this pest. Bored holes, heaps of excreta (either in pellet or in powder form) in and around the plants, general weakness of the plant, chlorotic leaves etc are the symptoms of stem borer infestation in vineyards. Severe infestation leads to the death of the plant.

The details of chemicals used for management these insect pests with their doses, time of application, MRL etc. are given in Annexure I of this document.

5.2 Management

5.2.1 General practices

Integrated disease and insect pest management in grapes for "Two pruning and single cropping" pattern followed in Maharashtra, Andhra Pradesh and Karnataka States.

As far as insects and pest management is concerned, there are many common management strategies need to be followed for the effective management of all the major insects and pests of grapes. Field sanitation like removal and burning of pruned plant parts, dried branches, weeds etc should be followed throughout the year in order to bring down the inoculums of the pest. Summer ploughing at the inter and intra row spaces of the plant is recommended to expose the pupal stages of pests like thrips, caterpillars, flea beetles etc., different stages of all pests and hiding stages of pests like mealybugs to sunlight. During the off season pests like mealybugs and mites hide under the bark of the plant, under the mulches near the root zone of the plant, and on the weed plants like *Cyprus* sp., *Parthenium* etc. In addition to this, plant debris after pruning and the defoliated leaves are also a source of both immature and adult mites. Therefore the removal and destruction of pruned plant parts, detached plant barks from the trunk and cordons, dried branches, weed plants etc are recommended to follow throughout the year. Ants help in the dispersion of pests like mealybugs from one plant to another. So check the vineyards for ant movement and manage them.

Regular scouting and monitoring is necessary to detect early infestations and also to take right management decisions at right time so that pesticide load on the crop can be reduced besides the effective management of insects and pests. In case of thrips, tap 5 randomly selected shoots per plant to a white paper and gently count them. If the count is more than 3-4 per leaf per plant after foundation pruning, initiate chemical control measures and after fruit pruning, especially during flowering and early berry setting stage, if the thrips count is more than 2-3/shoot or inflorescence/plant, initiate chemical control measures. In the case of mealybugs, check the number of colonies and if the infestation is more than 5 % especially after fruit pruning, chemical control measures can be initiated. If the mite population is 5-7 per leaf per plant especially during berry development stage till harvesting, chemical control measures can be initiated. During other seasons including the period after harvest, if the population is found to be 1-2 webbed colonies of mites/shoot/plant, resort to chemical control strategies. Chemical sprays should properly cover both sides of the leaf especially underside in the case of mite control and in case of mealybugs, the sprays should be more concentrated on the trunks, cordons and young buds rather than on the foliage. But for thrips, whole foliage spray especially on young shoots, flowers and bunches will give effective management. Pre harvest

interval (PHI) should be taken into consideration before spraying these chemicals on the exportable grapes.

If the pest population is below the economic threshold level (dealt above) biopesticides sprays like *Verticillium lecanii* or *Beauveria bassiana* @ 5 ml or 5 g/L during rainy season will help to manage various pests like mealybugs, thrips, mites etc. The spraying of biopesticides will also help to preserve the natural enemies like *Chrysoperla carnea*, lady bird beetles, syrphids etc in the vineyard. Ensure that fungicide sprays are not given in vineyards about 10 days before and after the sprays of bio-control agents. Whenever fungicide sprays are given after 10 days of the sprays of biocontrol agents, care should be taken that fungicide sprays are not directed to main stem. Release of Australian ladybird beetles @ 5000 beetles/Ha during April-May and December-January is good to manage mealybugs. Preferably the beetles can be released during the evening hours. For the caterpillar pests, set up pheromone traps @8-10/ha to lure the moths and kill them and application of Nuclear Polyhedrosis Virus (NPV) @ 250 LE/ha or *Bacillus thuriengiensis* (*Btk*) @1 kg/ha were found to be effective. Different neem formulations containing azadirachtin depending upon the strength of botanical viz., 1% @ 2.0 ml and 5% @ 1.0 ml/l were found to be effective in managing the various pests like thrips, jassids, mites and mealybugs.

5.2.2 Crop growth stage wise control measures

After foundation pruning (April to October)

Days after pruning or growth stage	**Control measure for insect pest**
Pre-Pruning Period	**Mealy bugs** If about 5 per cent of plants are found infested with mealy bugs in the vineyard then the pre-pruning spot spray application on only infested vines with methomyl 40 SP @ 1 g/L is found effective. **Mites** In the case of severe infestation, one jet of water spray before the acaricidal spray will reduce the pest load on the crop thereby getting an effective management of pests One spray of Fenpyroximate 5 SC @ 1.5ml/L to reduce the pest population. **Stem borer** The infested plants need to be treated individually. Check the bored holes, and if found plugged with excreta or wood powder, clean them using sharp tools like thin iron rod or wire. Try to make the holes wider as possible and hook out the larva and kill them.
8-12 days, or at Bud swelling stage	**Flea beetle** Generally flea beetles are minor pest of grapevine but if it becomes serious and present 2 to 3 adults per vine then spraying of Lambda-cyhalothrin 5 EC @ 0.5 ml/ L is found to be effective.
During active Shoot growth	For the control of Flea beetles, follow the insecticide spray recommended during bud swelling period.
(During April – May or 15 to 50 days of	**Mealybugs** Two sprays at an interval of 10 days using buprofezin 25 SC @ 1.25

Days after pruning or growth stage	Control measure for insect pest
back pruning)	ml/L was found to be effective in managing the pest. Drenching the soil between 30-40 days after foundation pruning with imidacloprid 70 WG @ 0.45 g/L/vine in the basins near active root zone around the trunk was found giving protection to young shoots from all the sucking pests. **Sucking insect pests** If the pest is above ETL (given in the text) spraying with Fipronil 5 SC @ 0.80ml/L or Fipronil 80 WG @ 0.05g/L was found to be effective. **Jassids** Control measures for thrips will take care of Jassids if the population reaches a threshold of 3-5 numbers/shoot/vine. **Stem Borer** As the adults are attracted to light, installation of light traps in the field will help to trap and kill the adults especially soon after rain.
After the onset of the monsoon (During June and July)	**Chaffer beetles** Spray of Lambda-cyhalothrin 5 EC @ 0.5 ml/ L for killing the adult chaffer beetles. Alternatively spray of EC formulation of azadirachtin 1% and 5% @ 2 ml/l and 1 ml/l respectively was found to act as an antifeedant for root grubs. **Mealybugs** Swabbing/washing of the trunk and cordons with Methomyl 40 SP @ 1.0g/l after the bark removal, will help to destroy the initial inoculum of mealybugs. Check for the ant movement and manage them. **Caterpillars** Light traps installed for the stem borer will reduce the insect population by attracting adult insects. Alternatively, install pheromone traps @ 6 nos./ ha to trap and kill adult moths. the population is considered above economic threshold level. If the pest population reaches economic threshold level of five moths per trap per day for three consecutive days application of NPV formulations like *Ha* NPV for *Helicoverpa armigera* and *Sl* NPV for *Spodoptera litura* @ 250 LE /ha is effective. Alternatively, spray using methomyl 40 SP @ 1 g/l was found to be effective.
August to October	**Mealy bugs** Use of biopesticides and botanicals as mentioned in the text is found to be effective in managing the pest. **Stem borer** Same care as mentioned for stem borer management during pre-pruning

Days after pruning or growth stage	Control measure for insect pest
	period (April-October) can be undertaken. If stem borer incidence is more than 60%, replanting of vineyard is advised..

After fruit pruning (October to March)

Days after pruning or growth stage	Control measure for insect pest
Pre pruning period	**Flea beetle** For the control of Flea beetles, follow the management practices mentioned during bud swelling.
Initiation of sprouting	**Flea beetle** For the control of Flea beetles, follow the management practices mentioned during bud swelling.
25 to 35 days	**Thrips** Use of yellow sticky traps @ 2/150 m^2 area for monitoring the population of thrips and leafhoppers. If more than 2-3 thrips per shoot are observed then spray with fipronil 80 WG @0.05 g/l is effective. **Leafhoppers** The chemicals (Mentioned before in the table for management of thrips) which are using for thrips will also take care of the leafhoppers. Mealy bugs Drenching of imidacloprid 70 WG @ 0.45 g/l/vine is effective in providing preventive management of mealy bugs.
36 to 50 days	**Thrips** Spraying of Spinosad 45SC @ 0.25 ml/l or Emamectin Benzoate 05 SG @ 0.22g/l or Lambda-cyhalothrin 05 EC @ 0.5 ml/l etc were found effective in controlling the pest. **Caterpillars** Follow the management practices mentioned after the onset of the monsoon during June and July. Caster plants and merry gold can be planted around vineyards as trap crops.
50-75 days	**Mealy bugs** If mealy bugs are found in more than 5 % of plants, two sprays at an interval of 10 days using buprofezin 25 SC @ 1.25 ml/L was found to be effective in managing the pest. It should be followed by two sprays of Verticillium lecanii @ 5 g/l at 10 days interval directing spray towards stem, cordons, buds and bunches. Avoid use of fungicides 10 days before and after the sprays of *Verticillium.* Thrips Spraying of emamectin benzoate 5 SG @ 0.22g/l is effective at this stage

Days after pruning or growth stage	Control measure for insect pest
	for managing thrips if pest population increases above 2-3 thrips per bunch or shoot.
	Mites Give adequate irrigation as water stressed plants are more prone to mite infestation. Follow managements mentioned earlier in the text as well as in the table. Spraying of Fenpyroximate 5 SC @ 1.5 ml/L was found to be effective in managing the pest.
75 to 90 days	**Mealy bugs** See the management practices which were mentioned in the text as well as in the table **Mites** See the management practices which were mentioned above (from 50 days onwards) **Thrips** Spraying with spinosad 45 SC @ 0.25 ml/l or lambda cyhalothrin 5 EC @ 0.5 ml/l is effective.

6. Management of diseases

Downy mildew, powdery mildew and anthracnose are the three important diseases caused by fungal pathogens and require warm and wet / humid conditions for causing infections. During monsoon, downy mildew and anthracnose are the major diseases noticed on the leaves, while powdery mildew appears when there is a long gap of rain with cloudy conditions. Rust infection appears on old leaves usually during September.

From April to first week of June usually the climate is hot with temperature ranging from 35-40^{o}C and dry with relative humidity > 40%, hence there is least possibility of development of any disease. However diseases occur during monsoon period when rains are received any time from second week of June till middle of October. In most grape growing areas 300 to 500 mm rain is received annually and there are about 30-45 days recording more than 4 mm rain per day from June to October.

By the time monsoon sets in, majority of the canes would have developed more than 12 leaves and shoot growth is normally brought under control. In the absence of growing shoots, application of non-systemic fungicides can give equally good results. Copper fungicides in general are broad spectrum and have good rain fastness, thus show good results during wet conditions. During September it rains in most of the grape growing areas and as a result of this diseased leaves drop off early. Accumulation of chlorides and salts in general, in saline areas also lead to early leaf drop. After leaves are dropped off the new shoots start growing, which not only attract infection of downy mildew and anthracnose, but also reduced stored food resources of the cane. Strategy of disease management after back pruning is, therefore, aims at

providing protection during wet weather, to reduce the disease on the first 12 leaves of the canes and to make them stronger to resist drop till forward pruning.

In most grape growing areas of Maharashtra, Andhra Pradesh and Karnataka, normal time of fruit pruning is around 15th of October, but it can range from first week of July to last week of November. From disease management point of view, forward pruning taken before 15th of October has greater risk of downy mildew, as there are more chances of rains and temperature is warmer. After forward pruning, about 8-10 days are needed for sprouting of buds. Thereafter on an average every three days interval new leaf is developed. At fifth leaf there will be a bunch, which takes about 35 to 45 days from forward pruning to develop to flowering stage and by 50 to 55 days fruits set in. First 50 to 55 days after pruning, risk of damages due to downy mildew infection on bunches is very high. Rains and heavy dew during this period helps development of downy mildew on bunches. Leaf wetness for continuous period of three hours after sunrise is favorable for new infection. If such conditions prevail during first 55 days of pruning, sprays of fungicides are needed at shorter intervals for effective control of downy mildew. Berries develop to 10 to 12 mm size within first 70-75 days of forward pruning and thereafter the risk of downy mildew gradually reduces. Rains during November and December are rare, but in years when it rains during November or thereafter, heavy losses due to downy mildew are observed. Normally, 5 to 6 sprays of fungicides are required during first 55 days of pruning for effective management of downy mildew. This number of sprays may be increased to 9 in the event of rains during November- December, while it can be reduced to 3-4 when wet weather is absent after forward pruning.

Details of chemicals, their doses, PHI, MRLs are given in Annexure I.

How to take decision on "what to spray?" and "when to spray?"

When new infection of downy mildew occurs?

Infection of downy mildew takes place when leaf, bunch or cane is wet during day time at least for 2.5 to 3.0 hours. Such condition is present when it rains or RH is very high after rains and fog or dew remains for long time in the morning.

Preventive spray is needed when new infection is likely

The vineyard needs to be protected when new infection of downy mildew is likely to take place. Therefore, 10 days onwards, after forward pruning the grower is expected to watch the vineyard for presence of dew on leaves and bunches, every morning. If the, temperature is above 10 ^{o} C, and dew is present on leaves after 9.0 am, the resulting leaf wetness period is sufficient to complete the process of new infection. Under such situation make your own observations on the following

- Whether the last spray of systemic fungicide for control of downy mildew was given within 3-4 days?
- If not, spray is required.
- If the spray was given within last 3-4 days, even though leaf wetness is present, spray may not be required till about 4 days have passed after this spray.
- However, decision can be taken based on

i. Weather forecast eg. If it is likely to rain within a day or two spray can be preponed

ii. presence of active inoculum of downy mildew in close vicinity e.g. if the oily spots (Photo) of downy mildew are seen in same or in nearby vineyard immediate spray may be needed.

Weather forecast helps in scheduling sprays

Location specific weather forecast for next 5 to 7 days is now a days available on internet. Information on forecast of rain is often useful in scheduling sprays, especially during critical stages of growth. In most cases rainy condition lasts for 2 to 3 days. Preventive spray given before rains often protects vineyard from downy mildew for 2 to 3 days of rainy condition. Even if new downy mildew infection takes place, its establishment and appearance of first symptom such as oily spots and subsequent sporulation needs at least 3 days after infection. This means if the preventive spray is given just before rains, the grower can safely wait for 3 to 4 days of rainy weather and give subsequent spray only after rains have stopped. However, this can be effectively done when location specific weather forecast is available.

NRC for Grapes, Pune gives summery of weather forecast of 7 days, for major grape growing areas on their web site. http://nrcgrapes.nic.in/

On this website click on menu "**Weather forecast based grape advice**" to get the weather forecast and related advice on plant protection. To know more details on weather at location of your interest one can see different links given on this page.

Note: Above weather information is summary of weather forecasting given in following websites
http://www.weather.nic.in/current.htm , http://www.imd.gov.in/section/nhac/wch/todaywch.htm ,http://www.imd.gov.in/section/nhac/distforecast/INDIA.htm
http://wxmaps.org/pix/prec6.html ,
http://www.accuweather.com/world-forecast.asp?partner=accuweather&traveler=0&locCode=ASI|IN|IN021|JUNNAR&metric=1 ,http://fallingrain.com

Important risk periods for downy mildew

While taking decision on sprays for downy mildew, growth stage related risk needs to be taken in to consideration.

First 50 days of forward pruning, especially after 10 days of pruning are important for management of downy mildew.

10 to 25 days after pruning new shoot is slowly growing. The vine receives N fertilizers during this period. To protect new shoots, two preventive sprays of systemic fungicides for downy mildew, preferably belonging to Low risk group as per Fungicide Resistance Action Committee (FRAC) classification**,** are required.

26 to 35 days after pruning : Young light green coloured bunch is just visible, and rapid elongation of cane is visible. Application of GA as spray or bunch dip, for bunch rachis elongation, is given during this period. GA application makes shoots and bunch more succulent and more sensitive to downy mildew. Two more preventive sprays of systemic fungicides for downy mildew are required during this period too.

36 to 50 days after pruning : After about 35 days after pruning the flowers in the bunch start opening. When flower cap starts separating, it allows dew water to

accumulate and remain on bunch for longer period. This leads to bunch infection of downy mildew even when weather is not very suitable for downy mildew. In case of mild infection losses could occur due to flower drop or by drying off of bunchlets. Hence, during this period 1 or 2 additional preventive sprays of systemic fungicides for downy mildew are required.

Care needed if it rains during December

By December most vineyards will have progressed beyond flowering and berry setting stage. In the event of normal weather, it rarely rains during December. Most grape growing areas in Maharashtra, Andhra Pradesh, and Karnataka temperatures will have considerably reduced and night temperatures will be close to 10°C.

Whenever, wet weather and young growing shoots are present there is a risk of downy mildew and anthracnose. High humidity, moderate temperature, and low light intensity due to crowded canopy or due to cloudy conditions increase the risk of powdery mildew.

After foundation pruning (April to October)

Days after pruning or growth stage	**Control measure for disease**
Pre-pruning period	**Downy mildew** Collect all downy mildew infected and dried bunches, leaves and canes from the vineyards before back pruning and burn them. Such operation may be essentially needed in vineyards with known attack of downy mildew during previous fruiting season. **General** Dead, dried wood present on arms, and dried bunches hanging on vine, should be removed and cut surfaces are pasted with Bordeaux paste.
Within 1-2 days after pruning	Spray vineyard with 1 % Bordeaux mixture within 1-2 days of pruning.
(During April – May or 15 to 50 days of back pruning)	**Anthracnose** Spray Carbendazim 50 WP, 1.0 g / L (1Kg / ha) at emergence of bud or immediately after rains for control of anthracnose. Add 25 to 30 g citric acid per 100 L of spray water before adding above fungicides to ensure that the pH of the spraying liquid is in acidic range. Spray Ziram 27 SL, 4.0 ml / L or Chloronthalonil 2.0 g / L or COC 3.0 g / L or Copper hydroxide 77WP 2.0 g / L, 7 -10 days after the spray of systemic fungicide. Spray of such non-systemic fungicide is needed when it rains after first spray. If any anthracnose infected new shoot is noticed, manually remove the shoot.
	Powdery mildew Spray Sulfur 80 WDG 2.0 g / L Or Potassium bi-carbonate 10.0 g / L Use of spreaders (Silwet or Sure-shot) 0.1 to 0.2 ml / L will improve the efficacy of above mentioned non-systemic compounds

Days after pruning or growth stage	Control measure for disease
	Ziram 27 SL 4.0 ml / L can be mixed with Sulfur if anthracnose is present along with powdery mildew.
After the onset of the monsoon (During June and July)	**Anthracnose / Bacterial leaf spot or stem canker / Downy mildew** Maintain about 12 leaves from the base. Spray copper fungicides COC 50WP, 3.0 g / L., or Copper hydroxide 77WP, 1.5 g /L or 0.5 % Bordeaux mixture to control all or any one of the three diseases. Alternatively spray of any non-systemic fungicide recommended for control of both downy mildew and anthracnose in Annexure I eg. ziram, mancozeb, captan, chlorenthalonil etc. Repeat after 10-15 days interval, during breaks in rain. By the end of July, if 2 to 3 sprays of copper fungicides are given depending up on rainfall pattern, outbreak of downy mildew or anthracnose is effectively controlled. In late pruned vineyards, where shoot growth up to first 10 to 12 leaves is still continuing, spray Carbendazim 50WP, 1.0 g/L alone or in combination with COC 50WP 2.5 to 3.0 g / L to control only anthracnose.
	Powdery mildew Spray Sulfur 80WDG, 2.0 g / L Or Dinocap 48EC, 0.25 to 0.30 ml / L Or Potassium bi carbonate 10 g/L . Use spreaders (Silwet or Sure-shot) 0.1 to 0.2 ml / L for better efficiency of above fungicides Do not spray Dinocap if tender shoots are present in canopy. At the end of July especially after the onset of monsoon downy mildew and powdery mildew can be present together in vineyards. In such situations mixture of Sulfur 80WDG, 2.0 g / L and 0.5 % Bordeaux mixture can be sprayed. The pH of the Bordeaux mixture should be adjusted after the mixing of sulfur. In case of potassium deficiency, spray of mono-potassium sulphate (0:52:34 grade of soluble fertilizers), or Sulphate of potash (SOP) 2-3 g / L could give considerable reduction in powdery mildew incidence. IN continuously cloudy climate spray any systemic fungicide belonging to triazole groups (eg. Hexaconazole, penconazole, flusilazole, myclobutanil, tebuconazole etc.) at regular recommended dose (Annexure-I) along-with potassium bicarbonate 5.0 g/L.

Days after pruning or growth stage	Control measure for disease
August to October	**Downy mildew, Anthracnose, Rust & Powdery Mildew.** Rub off new sprouts emerging after rains. Prefer spraying non-systemic fungicides (Bordeaux Mixture, Copper hydroxide, COC etc.) for the control of downy mildew, rust and anthracnose if disease is present on old leaves. Spray Sulphur 2 g/L. plus Bordeaux mixture 0.5% if both downy mildew and powdery mildew infection is present Use of copper fungicides mentioned above should control rust disease also. In case if the disease is found to increase, spray systemic fungicides such as, Flusilazole 40EC 0.025 ml / L. Spray formulations of *Tirchoderma* (*Trichoderma harzianum / T. viridi*) 2 to 5 g / L. One or two sprays at 10 days interval may be given when high humidity prevails. There should be gap of at-least 20 days between spray of fungicide and bio-control agent. Spray formulations of *Basillus subtills*, 1.0 ml/L for the control of powdery mildew Spray mineral oil formulation such as HP grape spray oil 5.0 to 10 ml/L. Such spray oils are not compatible with Sulfur and copper fungicides, and captan. Hence ensure that al-least 20 days have passed after the spray of such fungicides, before the spray of mineral oil formulations.

After fruit pruning (October to March)

Days after pruning or growth stage	Control measure for disease
Immediately after pruning	**Clean cultivation** All diseased vine parts, dead woods, removed barks, pruned remaining of vine and weeds should be removed Spray 1 % Bordeaux Mixture within 1-2 days of pruning on canes and arms to kill left over disease inoculums. Mix mancozeb 75 WP, 5 to 7 g/L with Hydrogen cyanamide solution for swabbing canes. This will help in killing pathogen inoculums (of downy mildew and anthracnose) if present on canes. If mancozeb is mixed with hydrogen cyanamide, use of red colour can be avoided as yellowish colour of mancozeb will help identifying treated cane in vineyard. If the un-pruned block is in close vicinity of pruned block, and the pruning in that block is not likely to take place within 5-8 days, it will be essential to spray 0.5 % bordeaux mixture in un-pruned block to avoid movement of inoculums from unpruned block to young shoots in pruned block. Sporangia of downy mildew can travel through air up to 100 m distance, while conidia of powdery mildew can be disseminated through air up to long distances.

Days after pruning or growth stage	Control measure for disease
	While staggering pruning in vineyards direction of air also should be taken in to consideration. Normally during October wind direction is East to west, hence early pruned blocks in the vineyard should be preferably in the eastern side so that there will be the least possibility of movement of airborne inoculums from unpruned blocks to new shoots in pruned block.
8 days after forward pruning	**Anthracnose, *Xanthomonas*** Spray systemic fungicides such as Carbendazim 1.0 g / L or difenconazole 25EC, 0.5 g/L, followed by non-systemic fungicides COC 3 g / L or copper hydroxide 77WP, 1.25 g/L after 2-3 days. Sprays of copper based fungicides can restrict the infection of bacterium *Xanthomonas*, and are useful in avoiding development of resistance in anthracnose pathogen against systemic fungicides.
10 days onwards	**Downy mildew** Sprays for downy mildew control are needed when new shoots remain wet due to dew up to 8 to 9 am in the morning or it rains during the day. Sprays of systemic fungicides are needed at every three days interval after 10 days of pruning. However, in the absence of rainy condition, and if morning dew is not very heavy, spray interval can be extended up to 5 days. One additional spray of non-systemic fungicides can be given between two systemic fungicides to reduce the risk of the disease. List of recommended systemic and non-systemic fungicides is given in Annexure The list is updated every year during October and is available on website of NRC for Grapes (http://nrcgrapes.nic.in) Spray anyone of the systemic fungicides from the list at 3 leaf stage, 5 leaf stage or 7 leaf stage as mandatory sprays, while maintaining spray interval at 5 days. Avoid using fungicides such as azoxystrobin, kresoxim methyl during first 18 to 20 days growth after forward pruning. Spray for downy mildew should be preventive and should be given before the start of rainy days or after the rainy days are over. If the rainy days are extended beyond 3 days, or when spray before the start of rainy days could not be given, or presence of downy mildew symptoms is observed in the vineyard or adjacent vineyard, spray non-systemic fungicides available as wettable powders (WP) can be applied as dusting.
25 to 35 days	**Downy mildew and anthracnose** Mix Fosetyl Al 3 g / L in solution of GA prepared for spray. Normally 2 to 3 sprays of GA are given. Only one of these sprays, preferably first or second, spray may be given along with Fosetyl Al. Time of spray may be decided considering, the time of spray of systemic fungicide for downy mildew given before the start of GA sprays. pH of spray solution of fosetyl al is acidic and hence helps better absorption of GA. However, if wet weather prevails during GA applications, spray of non-systemic fungicides other than copper fungicides is given after spray of fosetyl al and /or subsiquant spray of systemic fungicide is given at 3

Days after pruning or growth stage	Control measure for disease
	days interval instead of 5 days.
	Powdery mildew If cloudy climate prevails there will be increase in morning temperature and morning dew may remain for less time. Under such situation powdery mildew can develop sporadically in vineyards leading to development of inoculum. Spray Sulphur 80WDG 2.0 g / L. Avoid spraying sulphur after fruit set. If the cloudy climate persists for long period one spray of systemic fungicides recommended for powdery mildew (Annexure I) may be needed. Fungicide such as flusilazole has long PHI and is not recommended after fruit set due to residue problems can be preferred during this period.
35 to 50 days	**Downy mildew** It is most deceptive period, as even if there is no much dew in the morning hours, downy mildew may appear only on bunches, and cause flower drop, or complete destruction of bunch. Infection on leaves under such situation may be nil or minimum. About two preventive sprays of systemic fungicides for the control of downy mildew, at 5 days interval are essentially needed during this period. **Powdery mildew** Cloudy conditions will start the development of powdery mildew during this period. As most growers are more worried about downy mildew infection during this period, light infections of powdery mildew could be un-noticed. The worldwide it is observed that if powdery mildew infection is developed on bunches during flowering to fruit-set period, it becomes very difficult to control the disease on bunches during later stages. Especially it could lead to rachis infection of powdery mildew after veraison stage. Therefore at least one spray of systemic fungicide for the control of powdery mildew is needed during flowering stage. It is an ideal time for sprays of strabularin fungicides such as azoxystrobin 23SC or Kresoxim methyl 44.3 SC, as it will provide protection against both downy mildew and powdery mildew.
50 days onwards	**Powdery mildew** Ensure that vines do not suffer from potassium deficiency. In case deficiency is observed give sprays of potassium nitrates / Potassium sulphate / Monopotassium phosphate, are suggested. Follow the guidelines given under Nutrition. Spray any one of the recommended systemic fungicides at 7 to 10 days interval starting immediately after fruit set i.e. about 50 days of pruning. Spray interval can be decided on the basis of weather conditions or actual presence or absence of disease in vineyards. Whenever powdery mildew infection is seen in vineyard spray of tank mix of regular dose of systemic fungicide and Potassium bi carbonate 5 kg / ha is useful to eradicate left over powdery infections. Between two sprays of systemic fungicides non-systemic fungicide

Days after pruning or growth stage	Control measure for disease
	Dinocap 48EC, 25 ml/100 lit water can be sprayed up to 65-70 days after pruning. Most of the fungicides for the control of powdery mildew are given after fruit set. To avoid the residue of these fungicides in berries at harvest, recommended pre harvest intervals (PHI) and maximum residue levels (MRL) should be considered while selecting fungicide for spray at different growth stages. Normally, fungicides with long PHI and low MRL are selected for spray at early fruit growth stages. Use of flusilazole should be avoided after fruit set, while fungicides such as penconazole, and tridemefon should be selected up to first 80 days of pruning and hexaconazole or myclobutanil should be preferred close to veraison stage.
75 to 90 days	**Powdery mildew on bunches or rachis** Spray of strabularin fungicides such as azoxystrobin, which has PHI as low as 7 days, and MRL as high as 2.0 ppm. Hence such fungicide can be used for control of powdery mildew on bunches during last 30 days of berry maturity. Spray of sulphur 80WDG, 1.0 to 1.5 g / L can be given during last 20 to 30 days of berry maturity for the control of powdery mildew. Such sprays can be given alongwith good quality spreaders (Silwet or Sure-shot 0.05 to 0.1 ml / L) to avoid stains on berries. If less than 30 days are left application of formulations of bacteria such as *Basillus subtillis, Pseudomonas flurescence,* or mineral oils (HP Grape Spray oil 5 – 7 ml / L) or plant extract based formulations such as Sporekiller 2 to 4 ml /L or Tricure 4 to 5 ml / L can be used as spray on bunches for the control of powdery mildew without the risk of objectionable residue. Before application of any formulation few days before harvest it is advised to try the formulation first on few plants and if any spot or similar abnormality is not seen on berries the formulation can be used for spraying entire vineyard. **Post harvest diseases** *Trichoderma* sprays reduce post harvest rots of berries and increase shelf life depending up on quality of grapes. Pre harvest Spray treatment of *Trichoderma* spp. May be given Two sprays within the span of 15 days at weekly interval may be given using liquid formulations @ 5 ml / L. In the event of rains during pre-harvest period application of *Trichoderma* can be preponed.

7. Use of bioregulators for improving vine growth and fruit quality

Numerous growth regulators are being used in grape cultivation to increase its productivity and quality. Hormonal balance in any plant system is as delicately interwoven and as distinct as a spider web. Any imbalance created in the hormonal system by injudicious usage of the growth regulators will collapse the entire plant

system. So one has to use very judiciously and cautiously these growth regulators, not to cause any disturbance in the delicate balance of the endogenous hormones and the physiology of vines as a result of that specific hormonal composition of the system.

Quality improvement in grapes is aimed at the production of loose bunches, increasing berry size, its sugar content and firmness. While using growth regulators for quality improvement, it is to be borne in mind that growth regulators bring out improvement in quality through changing the growth or diverting the flow of metabolites into the berries, but do not increase the quality parameters by themselves directly. They are the mediators. The basic requirements are the metabolites, i.e. the carbohydrates or proteins in the plant system. In the absence of these metabolites in the plant system, use of growth regulators cannot bring about the desired effect.

A. Foundation pruning:

Sr. No.	Growth Stage	Chemical	Concentration (ppm)
1	After pruning	Hydrogen cyanamide @	1.5%
2	5 leaf stage	CCC	500
3	10 leaf stage or 7 + 5 leaf stage	CCC	500
4	40 days After pruning	6 -BA	10
5	45 days after pruning	Uracil	50
6	50 days after pruning	6 - BA	10

Forward pruning:

Sr.No.		Growth Stage	Chemical	Concentration (ppm)
1	1	After pruning	Hydrogen cyanamide	1.5-3.0 %
2	21-24	Prebloom spray	Gibberelic acid	10
3	23-27	2nd prebloom dip	Gibberelic acid	15
			Urea phosphate	1000
4	48-50	After berry set 3-4 mm	Gibberelic acid	40
		for white seedless	CPPU	2
		for color seedless		0.5
5	60-62	After berry set 6-7 mm	Gibberelic acid	30
6	50-70	Once before or at veraison stage	Calcium nitrate	10000

Bio-regulators are used in grape for various purposes viz. increasing fruitfulness, inducing bud break apart from increasing rachis elongation for production of well filled bunch, berry setting and also for increase in berry size besides quality improvement and increase in shelf life. Bioregulators with their nomenclature, doses, stage of application, care to be taken during application have been elaborated pointwise and given below:

Fruitfulness

The fruitful buds are formed during 40-70 days after April pruning. To increase fruitfulness in buds, the moisture stress as well as N fertigation has to be stopped to reduce the excess vigour of the vine.

Budbreak

After Forward pruning, hydrogen cyanamide @ 1.5-3.0 per cent a.i. (30-60ml/L active ingredient is 50%) can be used within 2 days of pruning as per thickness of the cane to increase the budbreak and also the uniformity in the budbreak. For achieving more uniformity in budbreak, only selected buds has to be treated with hydrogen cyanamide.

Cluster elongation

Clusters are treated with Gibberellic acid (GA_3) for cluster elongation, thinning and to increase berry size. GA_3 @ 10 ppm is used as foliar spray when the cluster is at parrot green stage. After 4-5 days, GA_3 @ 15 ppm can be given as a dip for rachis elongation and cluster growth.

Berry thinning

For thinning, if required GA_3 is sprayed @ 40 ppm when 50 percent of the flowers are opened in a cluster. This reduces the berry set and result in berry thinning. To enhance the efficacy of GA_3, the pH of the spray solution should be acidic (5 to 6.5). Treatment of GA_3 for thinning should not be taken if the rachis is well elongated and also when the weather is cloudy and is likely to rain. Otherwise, the entire flowers will drop.

Berry elongation

Treatment of GA_3 after berry set will increase their size by elongation. Care should be taken not to dip clusters where berries are yet to reach 3-4 mm size. If the berries are treated immediately after the set, thinning will be inadequate and more number of shot berries will form. Hence it is recommended to treat the clusters with GA_3 for berry elongation only after 3-4 mm size of berries.

Increasing berry diameter

For the export, berry diameter is more important than the berry length or the overall size of the berries. GA_3 along with CPPU (forechlorofenuron) @1-2 ppm can be used for increasing the berry diameter in seedless grapes. These bio-regulators must be used along with GA_3 @ 30- 40 ppm depending on the cluster and berry size. Therefore CPPU has to be used with the utmost care and only in vines having vigorous shoots.

With respect to use of bio-regulators, the stage of application and concentration plays very important role to achieve desired quantity and quality. To increase berry size (diameter) bio-regulators should be used at 3-4 mm berry size stage once and again at 6-7 mm berry size stage.

At berry size of 3-4 mm diameter

GA_3 @ 40 ppm + CPPU @ 1 ppm

At berry size of 6-7 mm diameter

GA_3 @ 30 ppm + CPPU @ 1 ppm

The above schedule has to be followed according to leaf / fruit ratio.

Retaining green colour of berries

The use of CPPU at 3-4 mm and 6-7 mm berry size stage may also be helpful to retain the green colour of berries at harvest.

Improving shelf life

Generally, post harvest berry drop in Thompson Seedless and its clones is very negligible. If in any case, the berry drop is more than permissible limits, this can be avoided either by increasing the pedicel thickness which can be achieved with the application of bio-regulators which are used at 3-4 and 6-7 mm berry size stage or dipping the clusters with calcium nitrate @ 1 % aqueous solution from 75 to 105 days after forward pruning or by treating the clusters with NAA @ 100 ppm in 2 split doses ten days prior to harvest.

Practices to produce loose bunches

Do's

i. Spray GA_3 @ 10 ppm at parrot green stage of cluster and 15 ppm GA_3 after a 4-5 days of 1st spray.

ii. GA_3 spray solution should be acidic (pH 5.5 - 6.5). Use citric *or* phosphoric acid *or* urea phosphate as a adjuvant to lower down the pH of spray solution

iii. Dip the clusters with 40 ppm GA_3 at 50% flowering if necessary. Treat individual cluster selectively.

iv. Cut the tips of clusters immediately after set by retaining 8-10 apical branches depending on the number of leaves available for a bunch.

v. Thin the berries manually before 3-4 mm berry size stage

vi. If thinning is inadequate remove the alternate branch of the rachis to retain 5-6 branches and clip the tip of the bunch 8 days after set.

vii. Use sufficient spray solution to have optimum coverage of foliage as well as clusters.

Don'ts

i. Do not use the solvent (acetone / methanol) more than 30 ml per g of GA_3.

ii. Do not spray pre-bloom GA_3 without fungicide if the weather is cloudy and humid, particularly if it is likely to rain to avoid excessive flower drop.

iii. Do not spray GA_3 at full bloom *or* immediately after berry set to avoid berry shatter and formation of shot berries.

iv. Do not girdle the vines before 3-4 mm berry size stage.

v. Avoid injury to the berries while thinning mechanically by scissors.

vi. Do not use IAA along with GA_3 for cluster elongation.

Regulation of bunch size

i. Thin out the shoots to retain only one per two square feet of ground area occupied by the vine, to build strong canes

ii. Restrict the growth of shoots to 15-18 leaves after back pruning by shoot topping after 75 days of back pruning.

Don'ts

i. Do not induce more bud break than required per cane. Three buds on canes thicker than 10 mm, two on canes with thickness of 8-10 mm and one on the canes with thickness ranging between 6-8 mm.

ii. Do not retain the canes that are thinner than 6 mm on the vines.

iii. Do not allow more than 15 leaves on a bearing shoot.

iv. Do not allow the clusters to develop on a shoot having less than 8 leaves.

Do's

i. Thin the berries and tip the cluster by 1/4 or 1/3 rd to retain 8 berries per leaf, when the leaf opposite to cluster is 16 cm wide, reduce the number of berries to 6 per leaf if its width is about 12 cm.

ii. 1-2 ppm CPPU to 30-40 ppm GA_3 and dip the clusters in the mixed solution once at 3-4 mm stage and again at 6-7 mm berry size stage. Selection of growth regulators for dipping should depend on the number of leaves available per bunch.

Don'ts

i. Do not allow the bearing shoots to have more than 15 leaves.

ii. Do not treat the clusters with CPPU when the bearing shoot has inadequate leaf area, and the shoots are less vigorous.

iii. Do not girdle the vines before the berries attain 3-4 mm berry size stage.

iv. Do not reduce the quantity of irrigation water during 60-105 days after forward pruning with a notion to increase the quality.

v. Do not delay berry thinning beyond 8-10 mm stage of berries.

Uniform size of berries in a bunch

Do's

i. Clip off the tip of the cluster by $1/3^{rd}$ or $1/4^{th}$ of its length, since the under developed berries are mostly formed in the lower half of the bunch.

ii. Ensure that all berries in a cluster receive all GA_3 treatments uniformly.

iii. Ensure adequate leaf/fruit ratio for a developing bunch (6-8 berries / leaf).

Don'ts

i. Do not treat the berries with GA_3 nor girdle the vines from berry set to shatter stage. Since this may lead to more shot berries in a bunch

Achieving uniform colour of berries in a bunch

Do's

i. Orient the rows in North-South direction when trained to flat roof gable system

ii. Irrespective of the size of the leaf, retain minimum 10 leaves above the cluster

iii. Orient the bearing shoots horizontally or diagonally on a slanting curtain

iv. Angle of the curtain should be 40°-45° to the vertical plane

v. Curtain height should be atleast 4 ft above the cordons

vi. Position the side shoots to cover the bunches borne on short shoots

Don'ts

i. Avoid training less vigorous vines to vertical trellises (T, V or Y).

ii. Do not orient the vine rows in East-West direction when trained to vertical trellises.

iii. Do not reduce the angle and the height of the curtain to less than 45° and 4 ft. respectively.

Increasing sugar content of berries

Do's

i. Orient the shoots so that all leaves are exposed to sunlight and the vine canopy is well illuminated and ventilated

ii. Remove the weak canes at forward pruning

iii. Girdle the vines at 3-4 mm size of berries.

iv. Ensure adequate leaf area per bunch.

v. Restrict the shoot growth to have not more than 15 leaves/bunch

vi. Remove the basal yellow leaves

Don'ts

i. A void over-crowding of shoots and natural shading of leaves.

ii. Avoid excessive irrigation after berry softening.

iii. Do not allow the clusters on weak shoots.

iv. Do not use CPPU for increasing the berry size in clusters borne on shoots with inadequate leaf area.

8. Maturity, harvesting and packaging

8.1 Maturity:

As grape is non-climacteric fruit, should be harvested when they are fully ripen since neither the colour nor the taste improves after harvest. Maturity standards of grapes fixed under the AGMARK states that the minimum TSS of 16^0B and sugar acid ratio of 20:1 and this has to be complied for export and domestic market. Characteristic uniform colour development is a reliable index of ripening in coloured varieties. In white varieties, uniform green colour is preferred in the export market.

8.2 Harvesting:

Only attractive bunches fulfilling minimum AGMARK quality requirement should be harvested. Harvesting should be done by skilled workers wearing soft rubber gloves and using sharp secatures / scissors for cutting.

Careful handling of grapes during harvesting, transporting, cleaning and packing is very essential to prevent injury and abrasion. The bunch should always be held the by the stem/ peduncle. Rough handling results in loss of bloom (thin wax coating on berry surface) making the berries susceptible to decay. Rubber gloves should be worn during cleaning operations and handling of bunches.

Time of harvesting

Bunches should be harvested during the early morning hours before the berry temperature rises above 20°C, so that the berry temperature can be brought down to 4°C by pre-cooling within four - six hours. In case of dew, harvesting should be delayed till the dew has dried. If rainfall has occurred just prior to harvest, the fruit should not be picked for at least 3-4 days. At harvest, the berries with visual symptoms of decay should be removed. These grapes should be cold stored separately and monitored for any development of decay.

Method of harvesting

A day prior to picking, the broken, along with decayed, deformed, undersized, and discoloured berries are removed by cutting their pedicel from the selected bunches, using a long nosed scissors. Care must be exercised not to injure other berries by the scissors. Clusters should never be held against the naked palm while cleaning, harvesting or trimming. They should be held by their stalk, preferably by wearing rubber gloves.

Bunch collection

Harvested bunches are placed gently in clean perforated plastic crates and left in the shade of the vines for subsequent transfer to pack-house. The crates should be lined with clean bubble sheets for cushioning and kept over newspapers spread on the ground to avoid contamination with vineyard dust. The bunches are kept in such a way that their stalks should not injure berries from other bunches.

Bunch Cleaning, Sorting and Grading

Trimming to remove immature, diseased, shrivelled, undersized, off-colour or under developed berries or side branches of the rachis should be done very carefully with sharp long nosed scissors to avoid injuries to the side berries. The berries should never be pulled out by hand as the portion of the pedicle along with pulp from the berry that remains attached to the bunch (wet brush) is a hot spot for development of decay causing organisms. Too compact or too straggly bunches or bunches with sun scorching or damage due to mealy bugs, powdery mildew, chemicals etc. or excessive water berries, etc. should be removed before grading and packing.

Bunches are graded based on the size and colour of berries and not on the shape of the bunch. Grading is done manually. While grading, the bunch should be held by the peduncle and care should be taken to avoid touching the berries/ bunch by the naked palm of the hand.

8.3 Storage

Pre-cooling

The temperature in the pack house should be maintained at 18-20°C and the grapes should be transported to pre-cooling units with 4-6 hours of harvest. The temperature of harvested grapes should be brought down to less than 4°C within six to eight hours in the pre-cooling chambers. If the pre-cooling units are away from the

production sites and packinghouses, mobile pre-cooling units are to be used. The filled boxes without closing the polyethylene liner are placed in the pre-cooling chambers.

Cold storage

After pre-cooling, the dual releasing sulphur dioxide pads (Grape guard) are placed with their coated surfaces facing downwards on the filled plastic pouches and covered with the plastic sheet lining. The boxes are closed and shifted to cold storage rooms where the temperature and humidity are maintained at 0 ± 0.5^{0}C and $93 \pm 2\%$ respectively. Temperature of 0°C and humidity of 95% are the best for maintaining freshness and preventing decay.

8.4 Transport

Conveyances and/or containers used for transporting food stuffs shall be kept clean and maintained in good conditions in order to protect foodstuffs from contamination and dust. Wherever necessary, be designed and constructed to permit adequate cleaning and/or disinfection. Conveyance and/or containers used for transporting foodstuffs must be capable of maintaining foodstuffs at appropriate temperatures. Hence, they should be designed in such a way to monitor those temperature at regular interval.

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Annexure-I
List of chemicals with CIB&RC label claim for use in grapes

राष्ट्रीय अंगूर अनुसंधान केन्द्र

(भारतीय कृषि अनुसंधान परिषद)

डाक पेटी नं. 3, मांजरी फार्म डाकघर, सोलापूर रोड, पुणे – 412307, भारत

NATIONAL RESEARCH CENTRE FOR GRAPES

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

P.B. NO. 3, MANJRI FARM POST, SOLAPUR ROAD, PUNE - 412 307, INDIA

Tel.: 020-26956000, 26956006, Fax: 020-26956099

Email: dirnrcg@icar.org.in, nrcgrapes@gmail.com; website: http://nrcgrapes.nic.in

Revision date: 5th December, 2011

Sr. No.	Chemical recommended for major disease & pest	Nature of chemical	Dose on formulation basis	EU MRL (mg/kg) updated as on 09/11/2011	Pre-harvest Interval (PHI in days)
I	**Downy Mildew**				
1.	Mancozeb 75 WP	NS	1.5-2.0 g/L	5.0	35 (avoid using after fruit set)
2.	Propineb 70 WP	NS	3.0 g/L	1.0	40 (avoid using after fruit set)
3.	COC 50 WP	NS	2.5 g/L, 2.4 g/L	50.0	42 (avoid using after fruit set)
4.	Chlorothalonil 75 WP	NS	2.0 g/L	1.0	60
5.	Fosetyl Al 80 WP	S	1.4-2.0 g/L	100.0	7
6.	Metalaxyl + Mancozeb 8+64 WP	S+NS	2.5 g/L	2.0 + 5.0	66
6a.	Metalaxyl-M + Mancozeb 4+64 WP	S+NS	2.5 g/L	2.0 + 5.0	66
7.	Cymoxanil + Mancozeb 8+64 WP	S+NS	2.0 g/L	0.2 + 5.0	66
8.	Dimethomorph 50 WP + Mancozeb 75WP as tank mixture	S+NS	0.5 to 0.75 g/L + 2.0 g/L	3.0 + 5.0	66
9.	Fenamidone + Mancozeb 10+50 WG	S+NS	2.5 to 3 g/L	0.5 + 5.0	66
10.	Azoxystrobin 23 SC	S	494 mL/ha	2.0	7
11.	Iprovalicarb + Propineb 5.5+61.25WP	S+NS	2.25 g/L	2.0 + 1.0	55
12.	Famoxadone 16.6 % + Cymoxanil 22.1 % SC	S+NS	500 mL/ha	2.0 + 0.2	27

Sr. No.	Chemical recommended for major disease & pest	Nature of chemical	Dose on formulation basis	EU MRL (mg/kg) updated as on 09/11/2011	Pre-harvest Interval (PHI in days)
13.	Kresoxim methyl 44.3 SC	S	600-700 mL/ha	1.0	30
14.	Fenamidone 4.44% + Fosetyl-Al 66.66% WDG	S	2 to 2.5 kg/ha	0.5 + 100	27
15.	Pyraclostrobin 5% + Metiram 55% 60WG	S+NS	1.5-1.75 kg/ha	1+5	15
16.	Mandipropamid 23.4% SC	NS	0.8 mL/L	2.0	5
II	**Powdery Mildew**				
17.	Penconazole 10 EC	S	0.50 mL/L	0.2	50
18.	Triadimefon 25 WP	S	0.50-1.0 g/L	2.0	45
19.	Hexaconazole 5EC	S	1.0 mL/L	0.1	38
20.	Myclobutanil 10 WP	S	0.40 g/L	1.0	30
21.	Flusilazole 40 EC	S	25 mL / 200 L	0.05	50
22.	Fenarimol 10 EC	S	0.40 mL / L	0.3	30
23.	*Difenoconazole 25EC*	S	0.50 mL / L	0.5	45
10a.	Azoxystrobin 23 SC	S	494 mL / ha	2.0	7
13a.	Kresoxim methyl 44.3 SC	S	600-700 mL/ha	1.0	30
24.	Dinocap 48 EC	NS	0.30 - 0.35 mL/L	0.05	50 (avoid application when tender shoots are present in canopy)
25.	Sulfur 40 SC, 55.16 SC, 80 WP, 80 WDG, 85 WP	NS	3.0 mL, 3.0 mL, 2.50 g, 1.87-2.50 g, 1.50-2.0 g/L, respectively		15
26.	Tetraconazole 3.8EW	S	0.75 mL/L		30
III	**Anthracnose**				
2a	Propineb 70 WP	NS	3.0 g/L	1.0	40
3a.	*COC 50 WP*	NS	2.5 g/L, 2.40 g/L	50.0	42 (avoid using after fruit set)
27.	Carbendazim 50 WP, 46.27 SC	S	1.0 g/L, 1.0 mL/L	0.30	50
IV	**Flea beetles**				
28.	Imidacloprid 17.8 SL	S	0.30 mL/L	1.0	60
29.	Clothianidin 50 WDG*	S	0.12 g/L	0.6	40

Sr. No.	Chemical recommended for major disease & pest	Nature of chemical	Dose on formulation basis	EU MRL (mg/kg) updated as on 09/11/2011	Pre-harvest Interval (PHI in days)
30.	Lambda-cyhalothrin 05 EC*	NS	0.50 mL/L	0.2	30
31.	Thiamethoxam 25 WG*	S	0.25 g/L	0.5	40
V	**Thrips**				
29a.	Clothianidin 50 WDG*	S	0.12 g/L	0.6	40
32.	Emamectin benzoate 05 SG	NS	0.22 g/L	0.05	25
33.	Fipronil 80 WG	NS	0.05 g/L	0.005	60
30a.	Lambda-cyhalothrin 05 EC *	NS	0.50 mL/L	0.2	30
34.	Spinosad 45 SC*	NS	0.25 mL/L	0.5	28
31a.	Thiamethoxam 25 WG*	S	0.25 g/L	0.5	40
VI	**Jassids**				
29b.	Clothianidin 50 WDG*	S	0.12 g/L	0.6	40
30b.	Lambda-cyhalothrin 05 EC *	NS	0.50 mL/L	0.2	30
31b.	Thiamethoxam 25 WG*	S	0.25 g/L	0.5	40
VII	**Mealy bugs**				
35.	Buprofezin 25 SC	NS	1.25 mL/L	1.0	40
36.	Methomyl 40 SP	NS	1.0 g/L	0.02	61 (one application only at pre-flowering stage)
37.	Imidacloprid 70 WG*	S	0.45 g/L/vine as soil drench	1.0	60
VIII	**Caterpillars (*Helicoverpa armigera* and *Spodoptera litura*)**				
34a.	Spinosad 45 SC*	NS	0.25 mL/L	0.5	28
30c.	Lambda-cyhalothrin 05 EC *	NS	0.50 mL/L	0.2	30
32a.	Emamectin benzoate 05 SG	NS	0.22 g/L	0.05	25
IX	**Mites**				
38.	Fenpyroximate 5 SC*	NS	1.5 mL/L	0.3	60
25a.	Sulphur 80 WDG	NS	1.50-2.0 g/L	50.00	15
X	**Plant Growth Regulators**				
39.	Hydrogen cyanamide 50 SL	S	30-40 mL/L	0.05	90-120

Sr. No.	Chemical recommended for major disease & pest	Nature of chemical	Dose on formulation basis	EU MRL (mg/kg) updated as on 09/11/2011	Pre-harvest Interval (PHI in days)
40.	Forchlorfenuron (CPPU) 0.1% L	S	1-2 ppm	0.05	22 (for 1 ppm dose) 30 (for 2 ppm dose)
41.	Gibberellic acid (GA3) Technical	S	100 ppm (Cumulative Usage)	5.00	7
42.	1-Naphthyl acetic acid 4.5% L	S	100 ppm	0.05	PHI data not available
43.	Chlormequat chloride 50 SL	S	250 ppm	0.05	PHI data not available
XI	**Herbicides**				
44.	Paraquat dichloride 24 SL	NS	5 mL/L	0.02	PHI data not available

NS = Non-systemic, S = Systemic

Note

- All the doses mentioned above are for high volume sprayers, where normal spray volume is 1000 L/ha. Spray volume can however be changed as per the efficiency of sprayers used. However, the amount of each pesticide based on its active ingredient recommended for 1 ha area on the basis of 1000 L spray solution should be strictly maintained to minimize pesticide residues.
- Recommended PHI will be valid only if two applications of an agrochemical are given per fruiting season at the interval of 7-15 days at recommended dose except in case of Flusilazole and Methomyl.

  The PHI of the fungicide Flusilazole and insecticide Methomyl pertains to one application by foliar spray only.
- Imidacloprid (17.8 SL or 70 WG) application (spraying or soil drenching) should not exceed more than two times per fruiting season.
- The chemicals at Sl. No. 42, 43 and 44 are having label claim for grapes with CIB&RC, but no PHI data is available for EU MRL. The farmers need to be cautious about the dose and stage of application as per the need.
- * As per the Office Memorandum F. No. 13035/18/2010-PP.I dated 21.10.2010 (extended for one year on 08.11.2011) of the Govt. of India, Ministry of Agriculture, Department of Agriculture and Cooperation regarding the label expansion of insecticides for control of insects-pests of grapes.
- The responsibility of usage of chemicals for the management of any of the above pests and diseases will rest with the growers in compliance with the requirements of the importers / EU and, in the minimum; all chemicals listed in Annexure 9 should be tested.

Annexure – II

Annexure – 9

Date: 9th November, 2011

List of Agrochemicals to be monitored for the grape season 2011-2012

Sr. No.	Chemicals	Harmonized EU-MRL (mg/kg) updated on 9th November 2011
I)	**Organochlorine**	
1.	Aldrin (Aldrin and dieldrin combined expressed as dieldrin)	0.01*
2.	Chlordane (cis & trans)	0.01*
3.	**Chlorothalonil****	**1.00**
4.	DDT (all isomers, sum of p,p´-DDT, o,p´-DDT, p,p´-DDE and p,p´-TDE (DDD) expressed as DDT)	0.05*
5.	**Dicofol** (sum of p, p´ and o,p´ isomers)**	**2.00**
6.	Dieldrin (see Aldrin)	0.01*
7.	Endosulphan (All isomers, sum of *alpha*- and *beta*-isomers and endosulphan sulphate expressed as endosulphan)	0.05*
8.	Endrin	0.01*
9.	HCH (sum of isomers, except the *gamma* isomer)	0.01*
10.	Heptachlor (sum of heptachlor and heptachlor epoxide expressed as heptachlor)	0.01*
11.	Lindane (*gamma*-HCH)	0.01*
II)	**Organophosphorus**	
12.	4-bromo-2-chlorophenol (metabolite of Profenophos)	0.01
13.	Acephate	0.02*
14.	Chlorfenvinphos	0.02*
15.	**Chlorpyrifos****	**0.50**
16.	Chlorpyrifos methyl	0.20
17.	Diazinon	0.01*
18.	Dichlorvos	0.01*
19.	Dimethoate (Including Omethoate)	0.02*
20.	Edifenphos	0.01
21.	Ethion	0.01*
22.	Etrimfos	0.01
23.	Fenitrothion	0.01*
24.	Fenthion (fenthion and its oxygen analogue, their sulfoxides and sulfone expressed as parent)	0.01*
25.	Glufosinate-ammonium (sum of glufosinate, its salts, MPP and NAG expressed as glufosinate equivalents)	0.10*
26.	Glyphosate	0.50
27.	**Iprobenphos****	**0.01**
28.	**Malathion** (sum of malathion and malaoxon expressed as malathion)**	**0.02***
29.	Methamidophos	0.01*
30.	Monocrotophos	0.01
31.	Omethoate (refer to Dimethoate)	0.02*

Sr. No.	Chemicals	Harmonized EU-MRL (mg/kg) updated on 9th November 2011
32.	Oxydemeton- methyl (sum of oxydemeton methyl and demeton-S-methylsulfone expressed as oxydemeton methyl)	0.01*
33.	Parathion ethyl	0.05*
34.	Parathion methyl (sum of Parathion methyl and paraoxon methyl expressed as Parathion methyl)	0.02*
35.	Phenthoate	0.01
36.	Phorate (sum of phorate, its oxygen analogue and their sulfones expressed as phorate)	0.05*
37.	**Phosalone****	**0.05***
38.	Phosphamidon	0.01*
39.	Pirimiphos-methyl	0.05*
40.	Profenophos	0.05*
41.	Propetamphos	0.01
42.	Quinalphos	0.05*
43.	Temephos	0.01
44.	Thiometon	0.01
45.	Triazophos	0.01*
III)	**Synthetic Pyrethroids**	
46.	Allethrin and Bioallethrin	0.01
47.	Bifenthrin	0.20
48.	Cyfluthrin (including other mixtures of constituent isomers sum of isomers)	0.30
49.	Cypermethrin (including other mixtures of constituent isomers sum of isomers)	0.50
50.	Deltamethrin	0.20
51.	Ethofenprox (Etofenprox)	5.00
52.	Fenpropathrin	0.01*
53.	Fenvalerate & Esfenvalerate (sum of RR & SS isomers)	0.10
54.	Fenvalerate & Esfenvalerate (sum of RS & SR isomers)	0.02*
55.	Lambda-cyhalothrin	0.20
56.	Permethrin (sum of isomers)	0.05*
57.	*tau*- Fluvalinate	0.10
58.	Transfluthrin	0.01
IV)	**Triazines**	
59.	Atrazine	0.05*
60.	Flufenzine	0.10
61.	Simazine	0.20
V)	**Acylamino acid fungicides**	
62.	Benalaxyl including other mixtures of constituent isomers including Benalaxyl-M (sum of isomers)	0.30
63.	**Metalaxyl ** & Metalaxyl-M**	**2.00**
64.	Oxycarboxin	0.05*
65.	Propanil	0.10*
VI)	**Carbamates**	

Sr. No.	Chemicals	Harmonized EU-MRL (mg/kg) updated on 9th November 2011
66.	Bendiocarb	0.01
67.	Benfuracarb	0.05*
68.	**Benomyl (see carbendazim)****	**0.30**
69.	**Carbaryl****	**0.05***
70.	Carbofuran (sum of carbofuran and 3-hydroxy-carbofuran expressed as carbofuran)	0.02*
71.	Carbosulfan	0.05*
72.	Dazomet (Methylisothiocyanate resulting from the use of dazomet and metam)	0.02*
73.	Fenobucarb	0.01
74.	Indoxacarb (sum of R and S isomers)	2.00
75.	Iprovalicarb	2.00
76.	**Methomyl** and Thiodicarb (sum of methomyl and thiodicarb expressed as methomyl)**	**0.02***
77.	Propoxur	0.05*
78.	Thiobencarb (Benthiocarb)	0.10*
79.	Thiodicarb (see Methomyl)	0.02*
VII)	**Pyrimidines**	
80.	Fenarimol	0.30
VIII)	**Triazoles**	
81.	Bitertanol	0.05*
82.	Difenoconazole	0.50
83.	**Flusilazole****	**0.05**
84.	**Hexaconazole****	**0.10**
85.	**Myclobutanil****	**1.00**
86.	Paclobutrazol	0.05
87.	**Penconazole****	**0.20**
88.	Propiconazole	0.30
89.	Tebuconazole	2.00
90.	**Tetraconazole****	**0.50**
91.	**Triadimefon **(sum of triadimefon and triadimenol)**	**2.00**
IX)	**Imidazole**	
92.	**Fenamidone****	**0.50**
93.	**Iprodione****	**10.00**
X)	**Oxazole**	
94.	Famoxadone	2.00
XI)	**Phthalimide**	
95.	Captafol	0.02*
96.	**Captan****	**0.02***
XII)	**Benzimidazole**	
97.	**Carbendazim (including Benomyl)****	**0.30**
98.	Thiophanate-methyl	0.10*
XIII)	**Dithiocarbamates**	

Sr. No.	Chemicals	Harmonized EU-MRL (mg/kg) updated on 9th November 2011
99.	**Dithiocarbamates (Mancozeb**,** Maneb**, Propineb**,** Metiram**,** Thiram**, Zineb** and Ziram** collectively estimated as CS2)**	**5.00**
XIV)	**Nicotinoids**	
100.	Acetamiprid	0.20
101.	Clothianidin (see thiamethoxam)	0.60
102.	**Imidacloprid****	**1.00**
103.	Thiacloprid	0.02*
104.	Thiamethoxam (sum of thiamethoxam and clothianidin expressed as thiamethoxam)	0.50
XV)	**Dinitrophenol**	
105.	**Dinocap** (sum of dinocap isomers and their corresponding phenols expressed as dinocap) and Meptyldinocap**	**0.05***
XVI)	**Aliphatic Nitrogen fungicides**	
106.	**Cymoxanil****	**0.20**
XVII)	**Morpholine**	
107.	**Dimethomorph****	**3.00**
108.	Tridemorph	0.05*
XVIII)	**Substituted Thiourea**	
109.	Diafenthiuron	0.01
110.	**Diuron** (Diuron including all components containing 3,4- dichloroaniline moiety expressed as 3,4-dichloroaniline)**	**0.05***
111.	Iodosulfuron-methyl (iodosulfuron-methyl including salts, expressed as iodosulfuron-methyl)	0.02*
112.	Isoproturon	0.05*
113.	Linuron	0.05*
114.	Lufenuron	1.00
115.	Pencycuron	0.05*
XIX)	**Benzoylphenyl urea**	
116.	Flufenoxuron	1.00
XX)	**Strobilurin**	
117.	**Azoxystrobin****	**2.00**
118.	Kresoxim methyl	1.00
119.	Pyraclostrobin	1.00
120.	Trifloxystrobin	5.00
XXI)	**Phenyl pyrazole**	
121.	**Fipronil** (sum of fipronil + sulfone metabolite (MB46136) expressed as fipronil)**	**0.005***
122.	Chlorantraniliprole	1.00
XXII)	**Pyrazole**	
123.	Fenpyroximate	0.30
XXIII)	**Nitrophenyl ether**	
124.	Oxyfluorfen	0.10

Sr. No.	Chemicals	Harmonized EU-MRL (mg/kg) updated on 9th November 2011
XXIV)	**Dinitroaniline**	
125.	Pendimethalin	0.05*
126.	Trifluralin	0.10*
XXV)	**Anilide/acetanilide and chloroacetanilide**	
127.	Alachlor	0.05*
128.	Butachlor	0.01
129.	Carboxin	0.05*
130.	Flufenacet (sum of all compounds containing the N fluorophenyl-N-isopropyl moiety expressed as flufenacet equivalent)	0.05*
131.	Metolachlor (with S-Metolachlor)	0.05*
132.	Novaluron	0.01*
XXVI)	**Miscellaneous group of chemicals**	
133.	**1-Naphthylacetic acid (alphanapthyl acetic acid)****	**0.05***
134.	**2,4-D (sum of 2,4-D and its esters expressed as 2,4-D)****	**0.05***
135.	6-Benzyl adenine	0.01
136.	Abamectin (sum of avermectin B1a, avermectinB1b and delta-8,9 isomer of avermectin B1a)	0.01*
137.	Azadirachtin	1.00
138.	Bifenazate	0.01*
139.	**Buprofezin****	**1.00**
140.	Cartap hydrochloride	0.01
141.	Chlorfenapyr	0.05*
142.	**Chlormequat (CCC)****	**0.05***
143.	Diflubenzuron	1.00
144.	**Homobrassinolide**	**0.01†**
145.	Diquat	0.05*
146.	Dithianon	3.00
147.	Dodine	0.20*
148.	**Emamectin Benzoate****	**0.05**
149.	Ethephon	0.70
150.	Fenazaquin	0.20
151.	Flubendiamide	1.00
152.	**Forchlorfenuron (CPPU)****	**0.05***
153.	**Fosetyl-Al (sum fosetyl + phosphorous acid and their salts, expressed as fosetyl)**	**100.00**
154.	**Gibberellic acid****	**5.00**
155.	Hexythiazox	1.00
156.	**Hydrogen cyanamide (Cyanamide including salts expressed as cyanamide)**	**0.05***
157.	Isoprothiolane	0.01
158.	Mandipropamid	2.00
159.	Mepiquat	0.30
160.	Metribuzin	0.10*

Sr. No.	Chemicals	Harmonized EU-MRL (mg/kg) updated on 9th November 2011
161.	Milbemectin (sum of MA4+8,9Z-MA4, expressed as milbemectin)	0.05*
162.	Oxadiazon	0.05*
163.	**Paraquat****	**0.02***
164.	Propargite	7.00
165.	Pyriproxyfen	0.05*
166.	Spinosad (sum of Spinosyn A+D)	0.50
167.	Spiromesifen	0.02*
168.	Trichlorfon	0.50
169.	Tricyclazole	0.05*
170.	**Uracil**	**1.00†**
XXVII)	**Inorganic**	
171.	Cadmium	0.05#
172.	**Copper compounds (**all copper fungicides as elemental Cu; **Bordeaux Mixture, Copper oxychloride, Copper hydroxide)****	**50.0**
173.	Lead	0.20#
174.	**Sulphur**	**50.0**

* EU-MRL set at LOQ (mg/kg) as per http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=substance.selection

† These are natural products. EU-MRL does not exist for these chemicals. Hence, their MRL is set at the LOQ of the method developed and validated at the National Referral Laboratory of the NRC for Grapes.

** Pesticides registered for use in grapes for control of insect pests, diseases and weeds approved by the CIB of Ministry of Agriculture, Government of India, New Delhi under the Insecticides Act 1968

#Reference: Commission Regulation (EC) No 1881/2006 of 19th December 2006